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Macalister

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(54) **FLIGHT SIMULATOR YOKE**

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(60) Provisional application No. 61/028,674, filed on Feb. 14, 2008.

(51) **Int. Cl.**
G09B 9/28 (2006.01)
G09B 9/02 (2006.01)

(52) **U.S. Cl.**
CPC ... ***G09B 9/28*** (2013.01); ***G09B 9/02*** (2013.01)

(58) **Field of Classification Search**
CPC G09B 9/00; G09B 9/02; G09B 9/08; G09B 9/28; G09B 19/16; G09B 19/165; A63F 13/06
USPC 434/29, 30, 35, 45; 463/37, 38; 446/7
See application file for complete search history.

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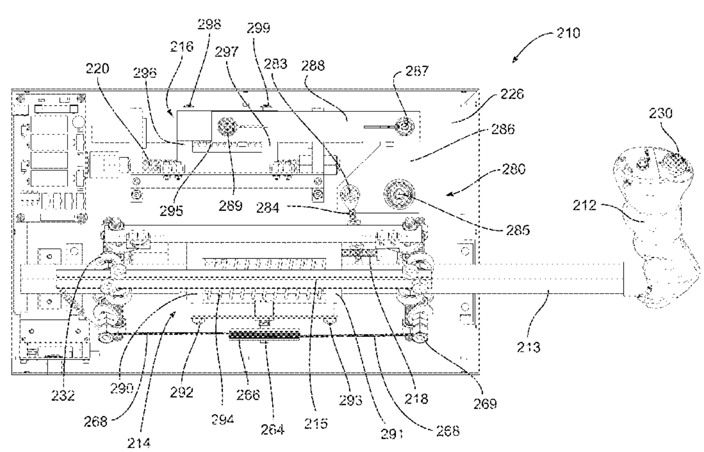
(57) **ABSTRACT**

A flight simulator yoke is provided having a single handle having a handgrip and yoke shaft operable from a left side of a user, wherein a neutral position for the handle is at a 45 degree angle. The yoke may further include two trim axes parallel to each other; and two moveable spring devices. The spring devices are operatively coupled to the trim axes, each spring device having a positive center detent, wherein the positive center detent requires a predetermined amount of force in order to move the yoke along each trim axis. The flight simulator yoke may simulate a yoke of a Cirrus aircraft.

9 Claims, 16 Drawing Sheets



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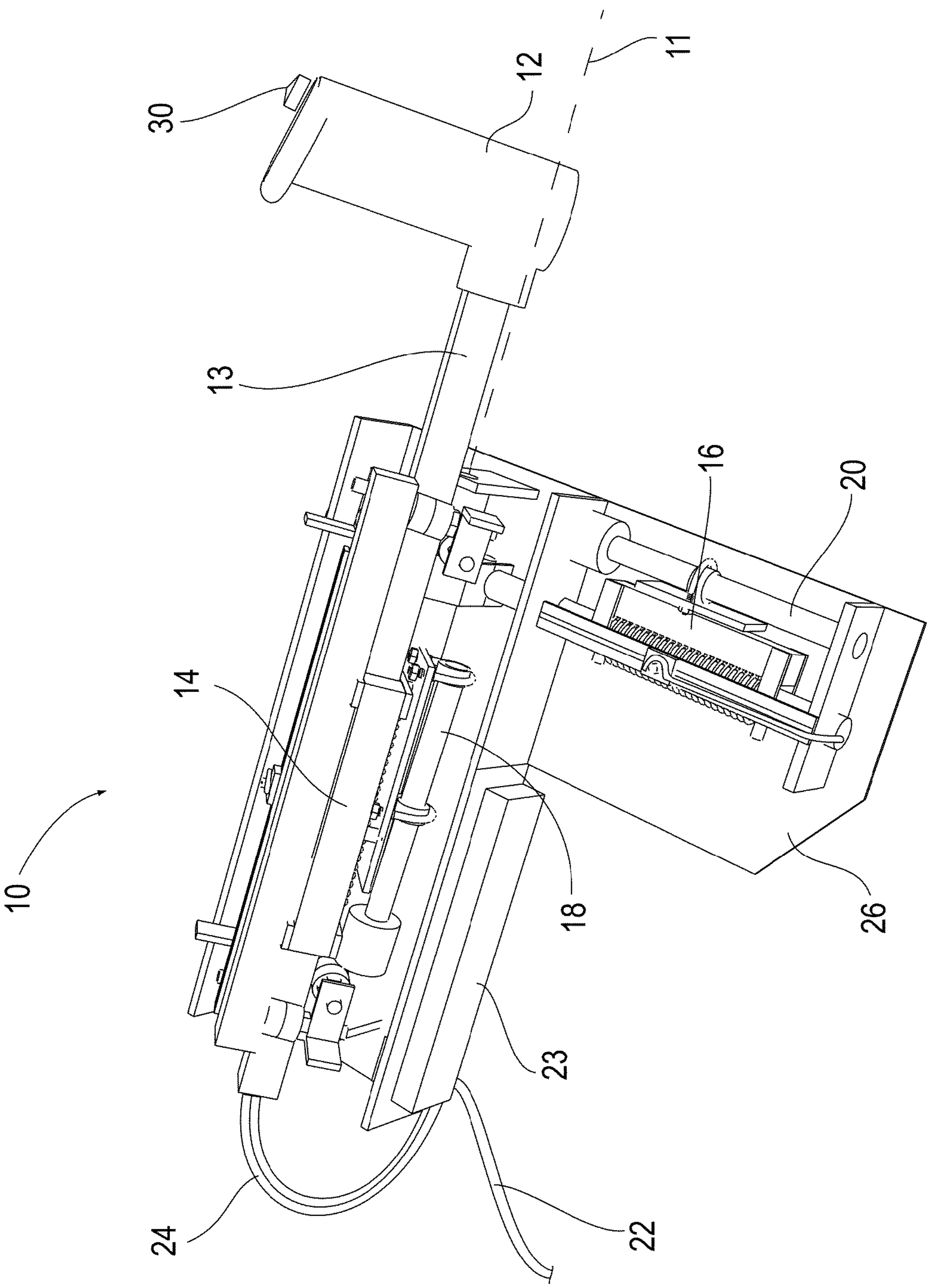

FIG. 1

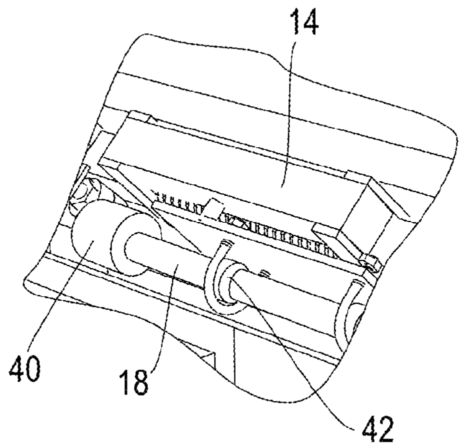

FIG. 2A

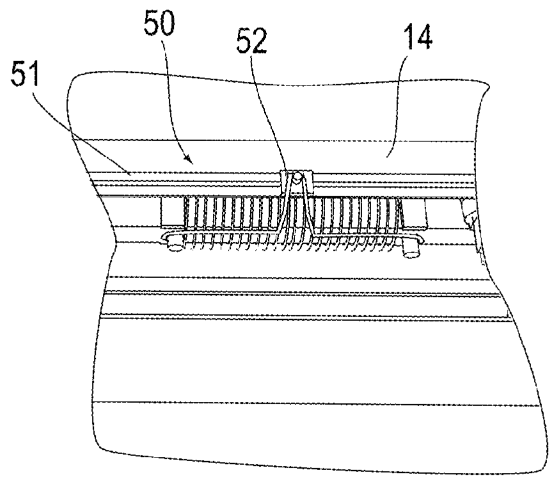

FIG. 2B

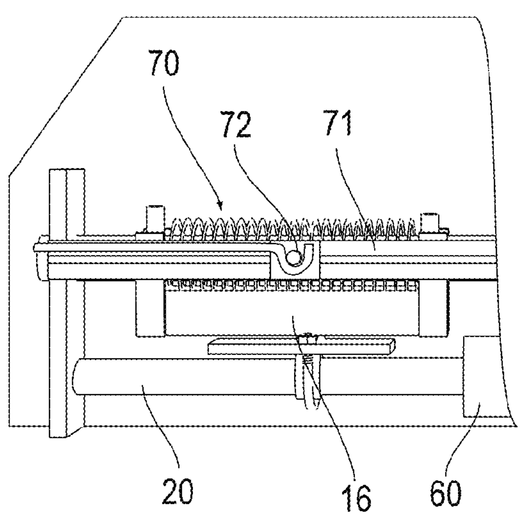

FIG. 3

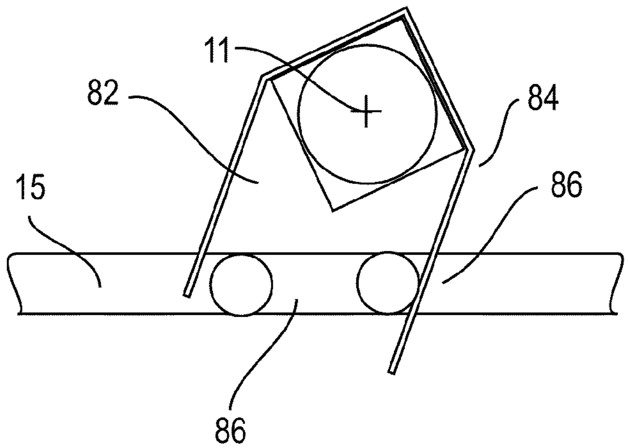

FIG. 4A

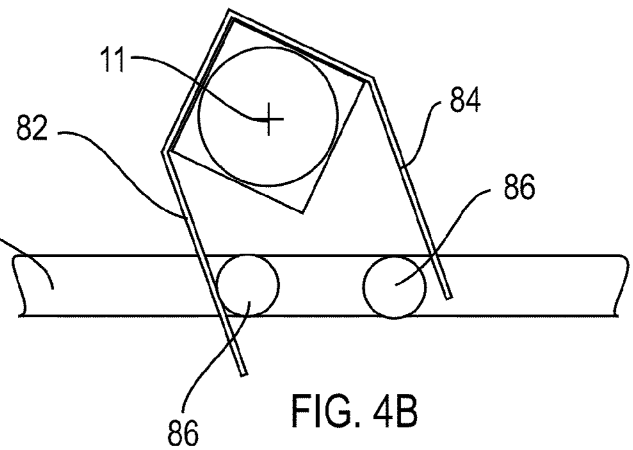

FIG. 4B

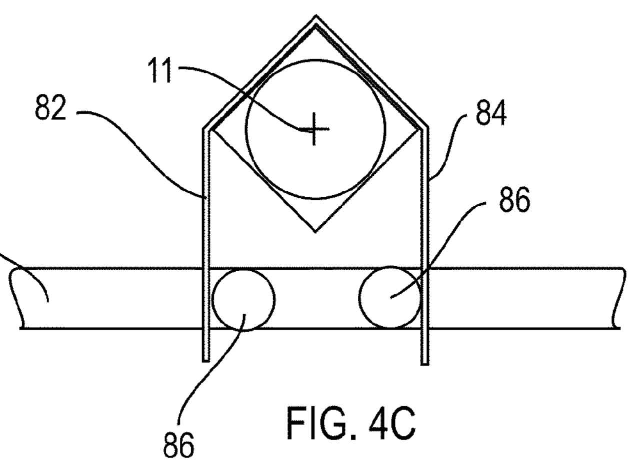

FIG. 4C

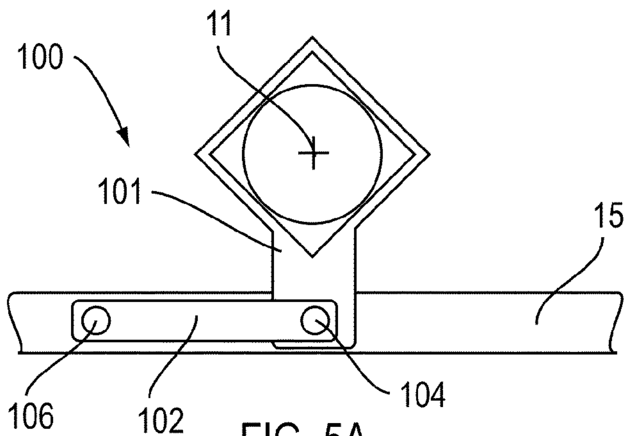

FIG. 5A

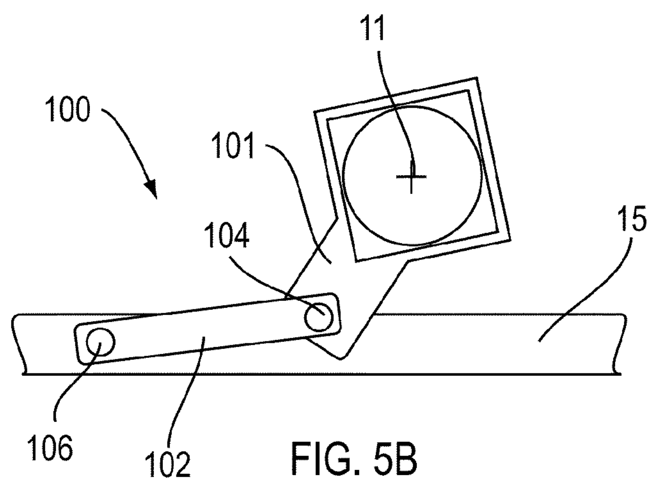

FIG. 5B

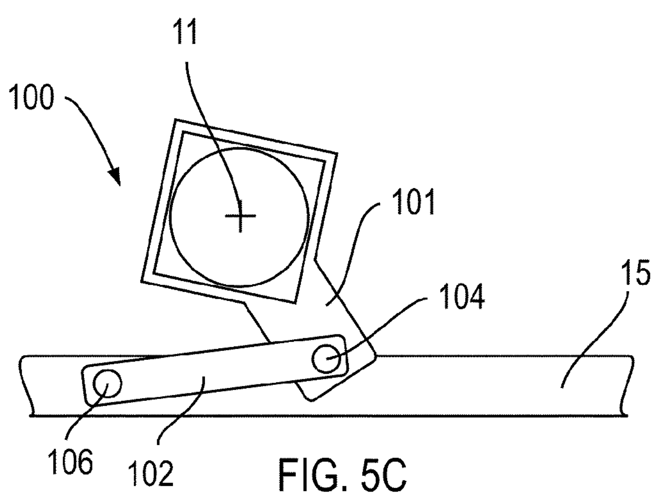

FIG. 5C

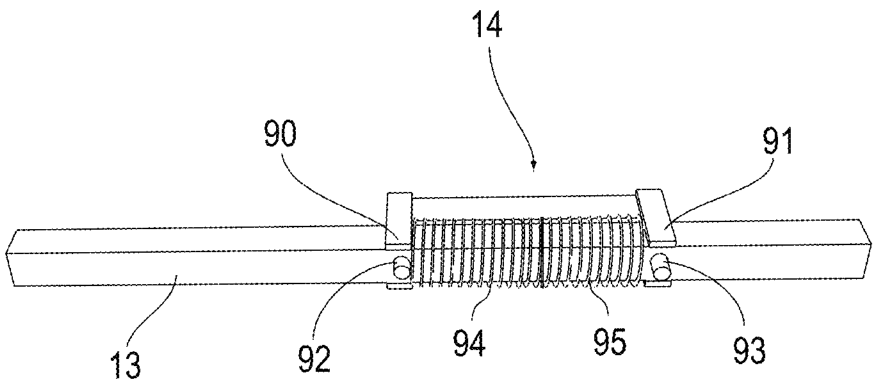

FIG. 6A

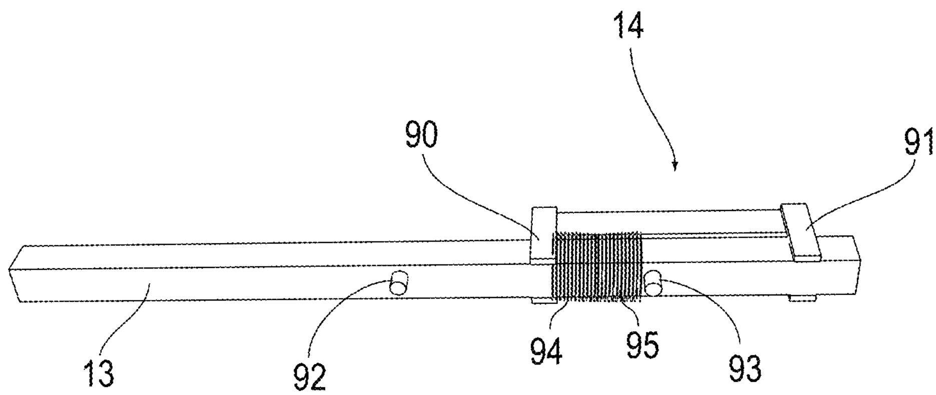

FIG. 6B

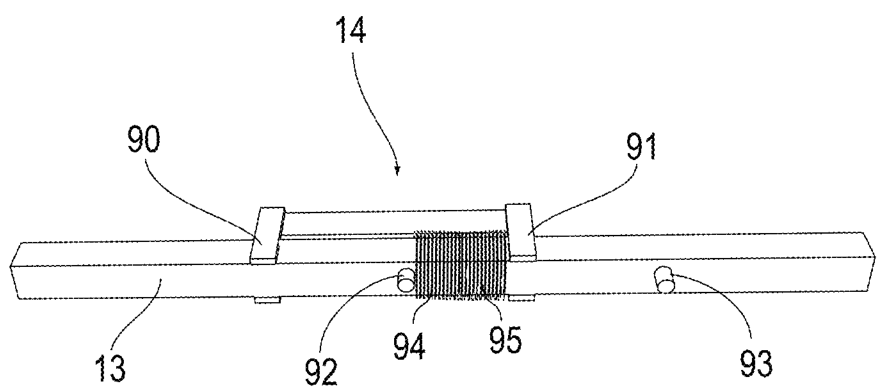

FIG. 6C

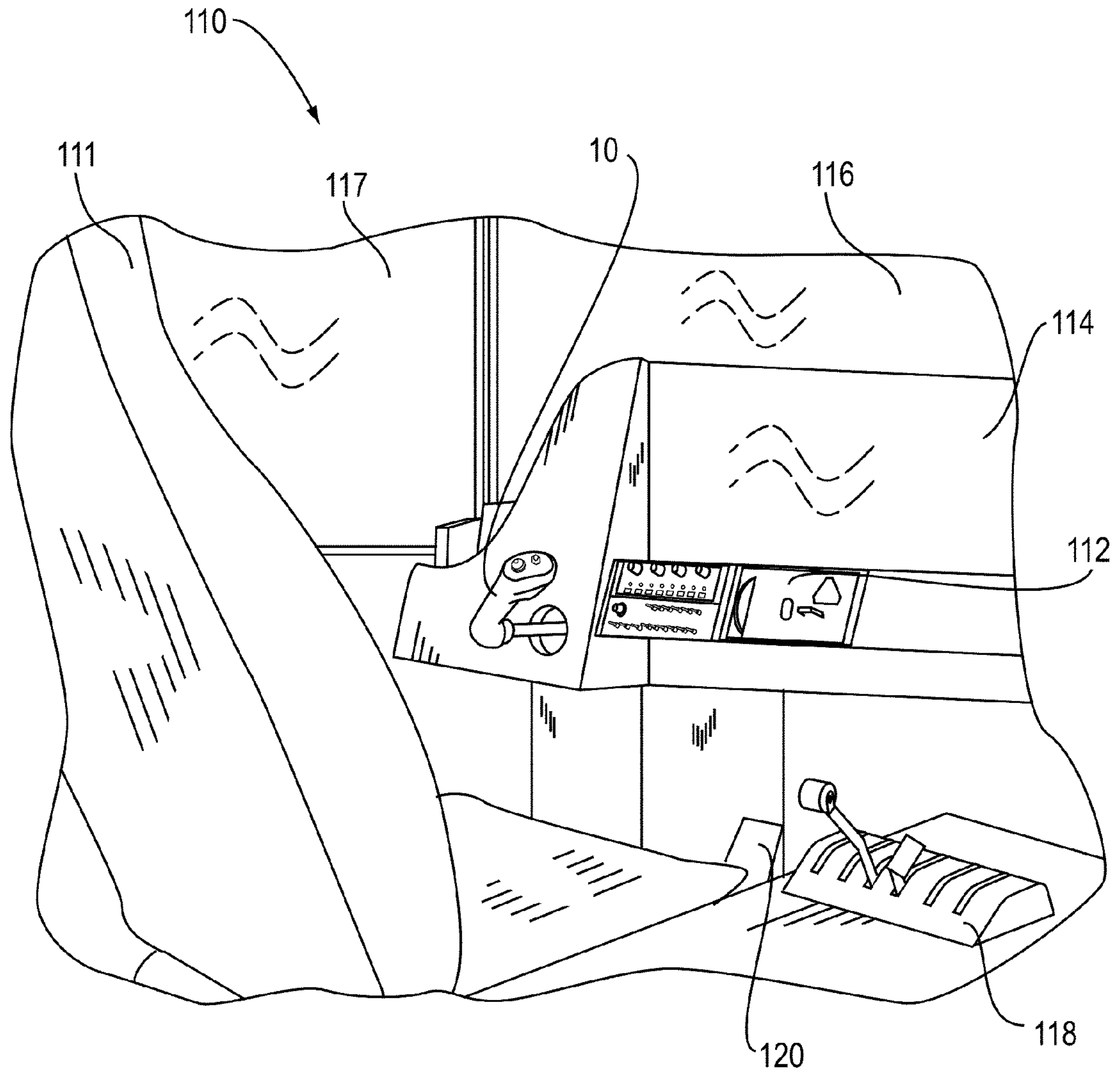

FIG. 7

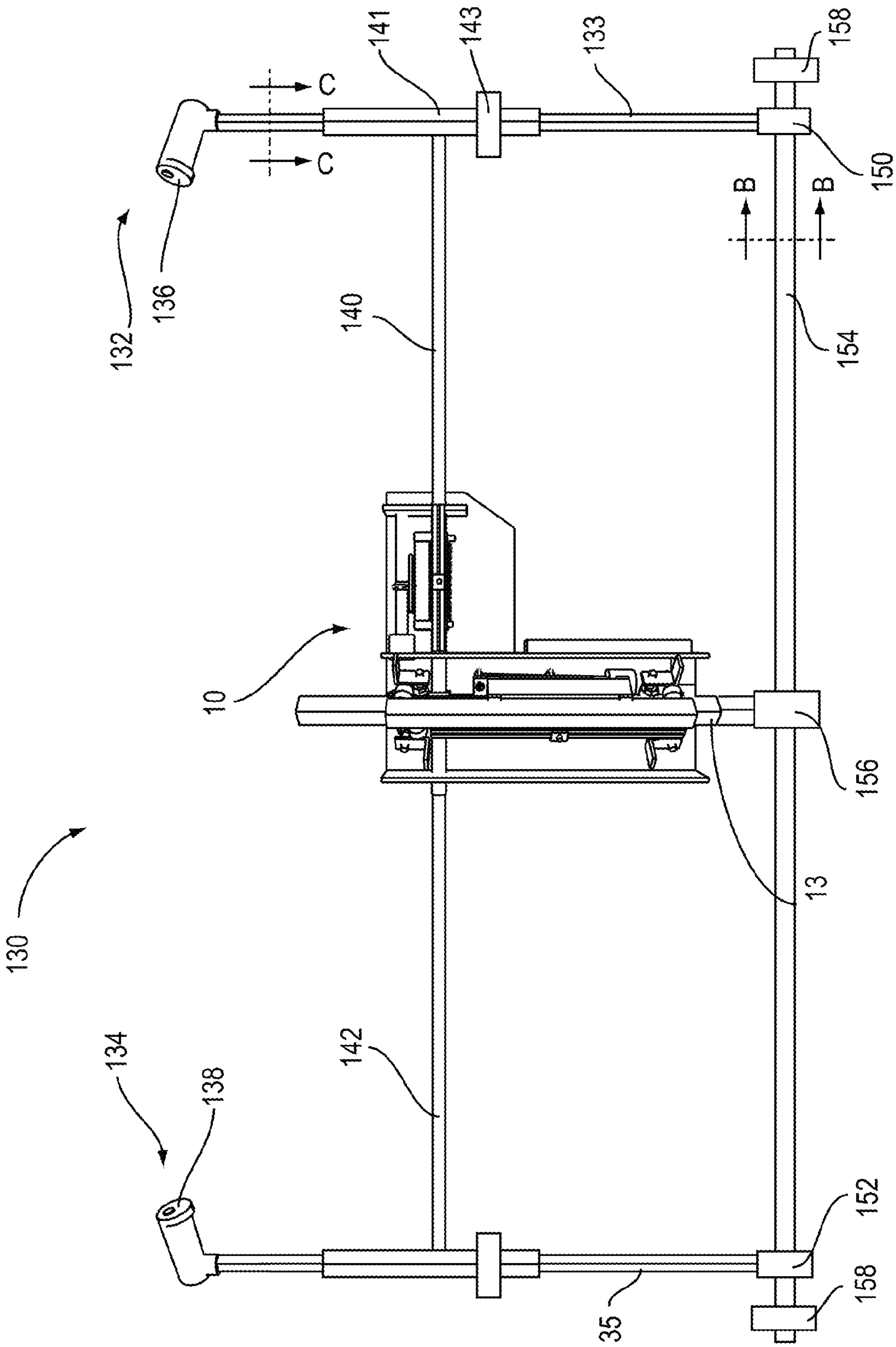

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FIG. 8A

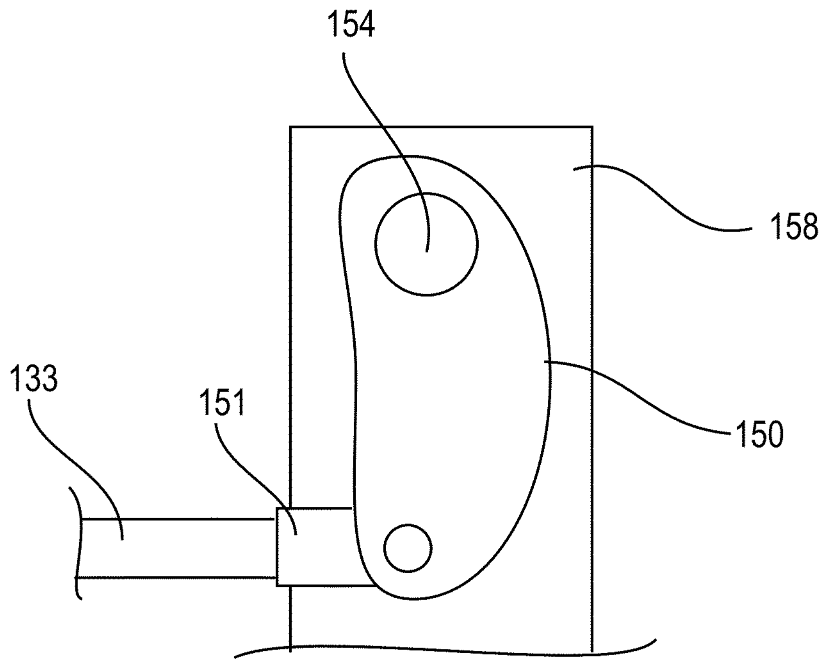

FIG. 8B

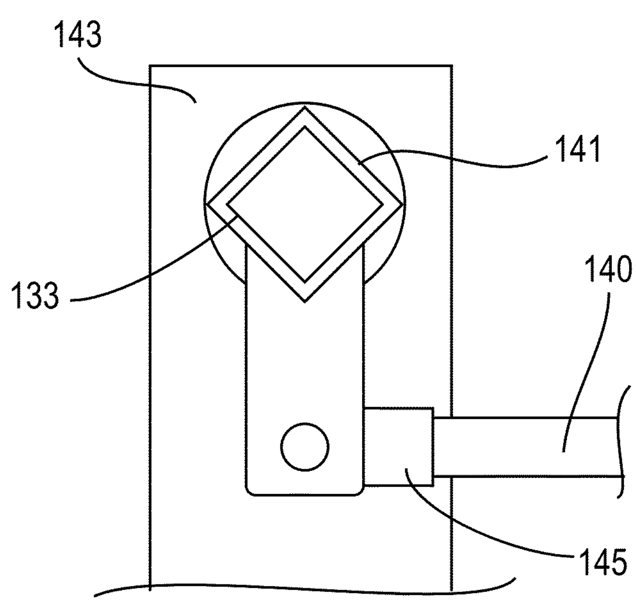

FIG. 8C

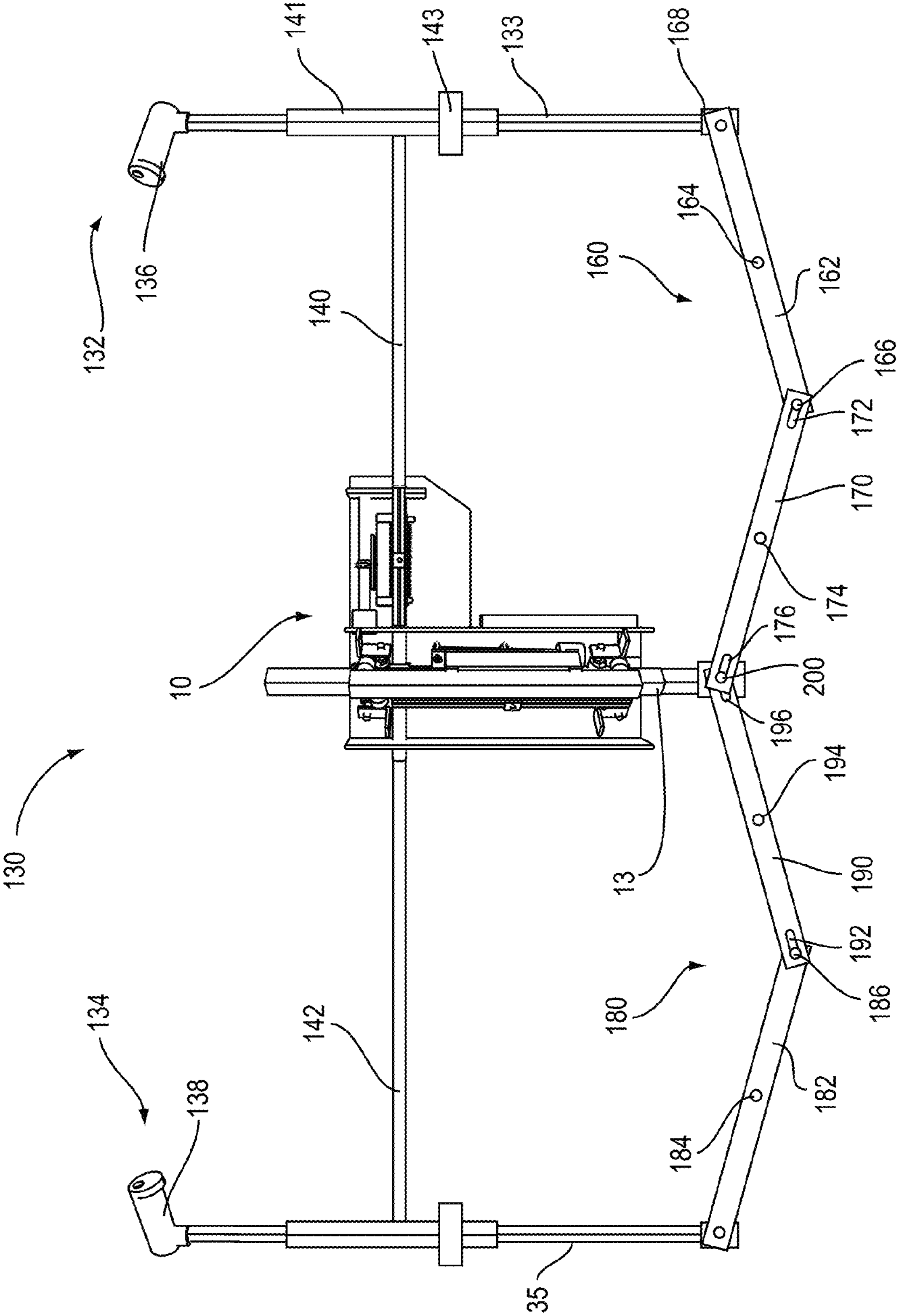
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FIG. 8D

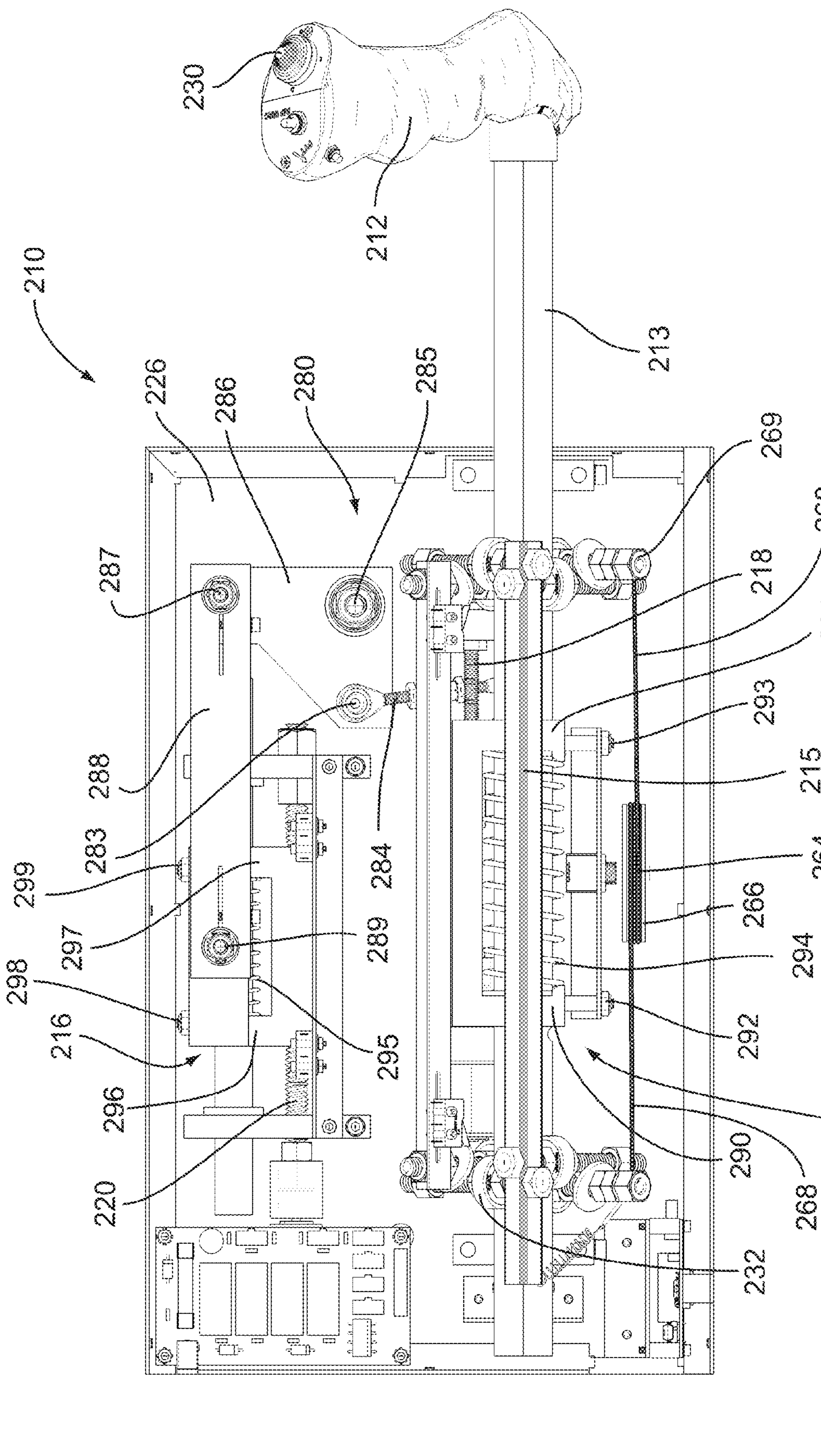
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FIG. 9

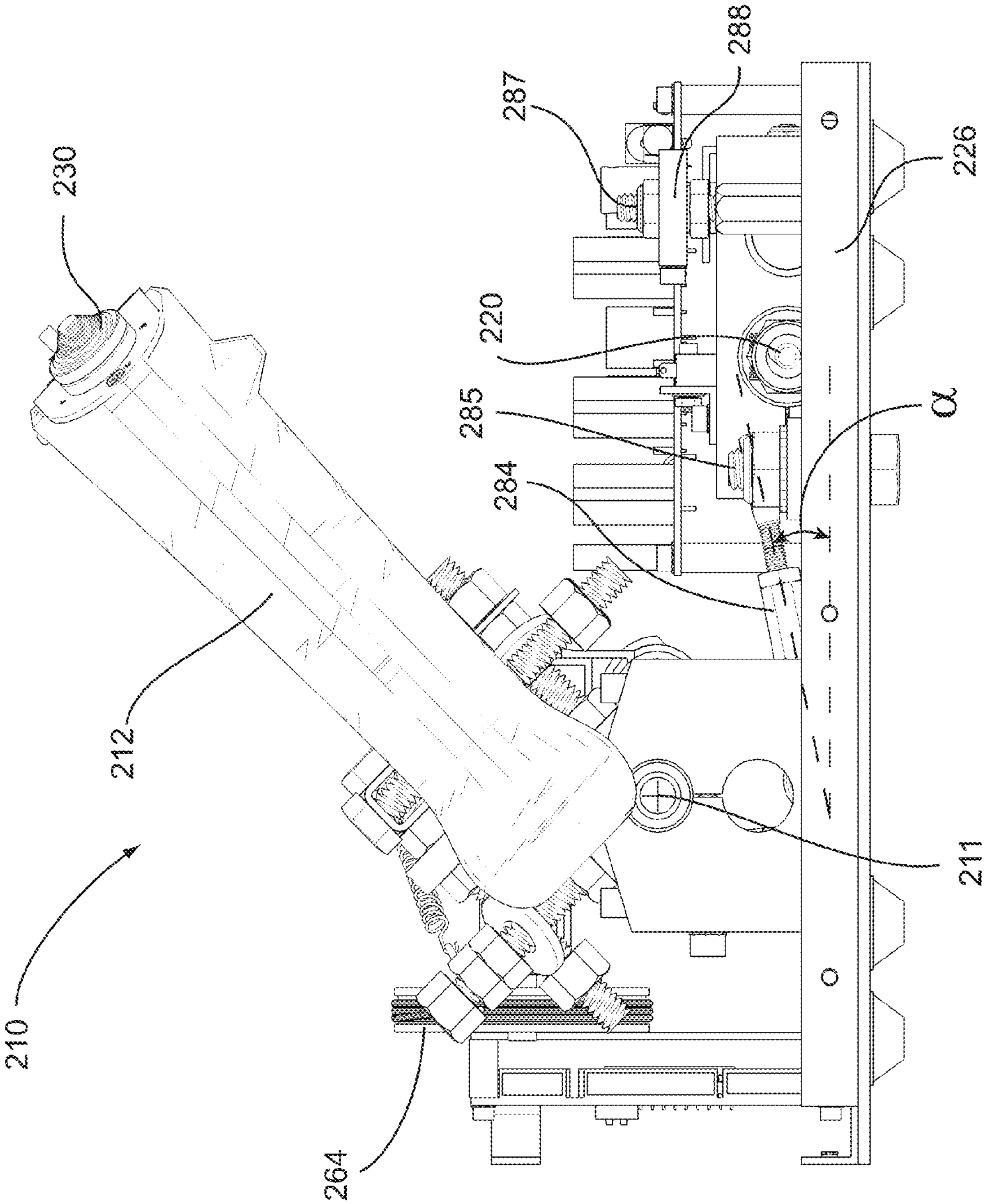
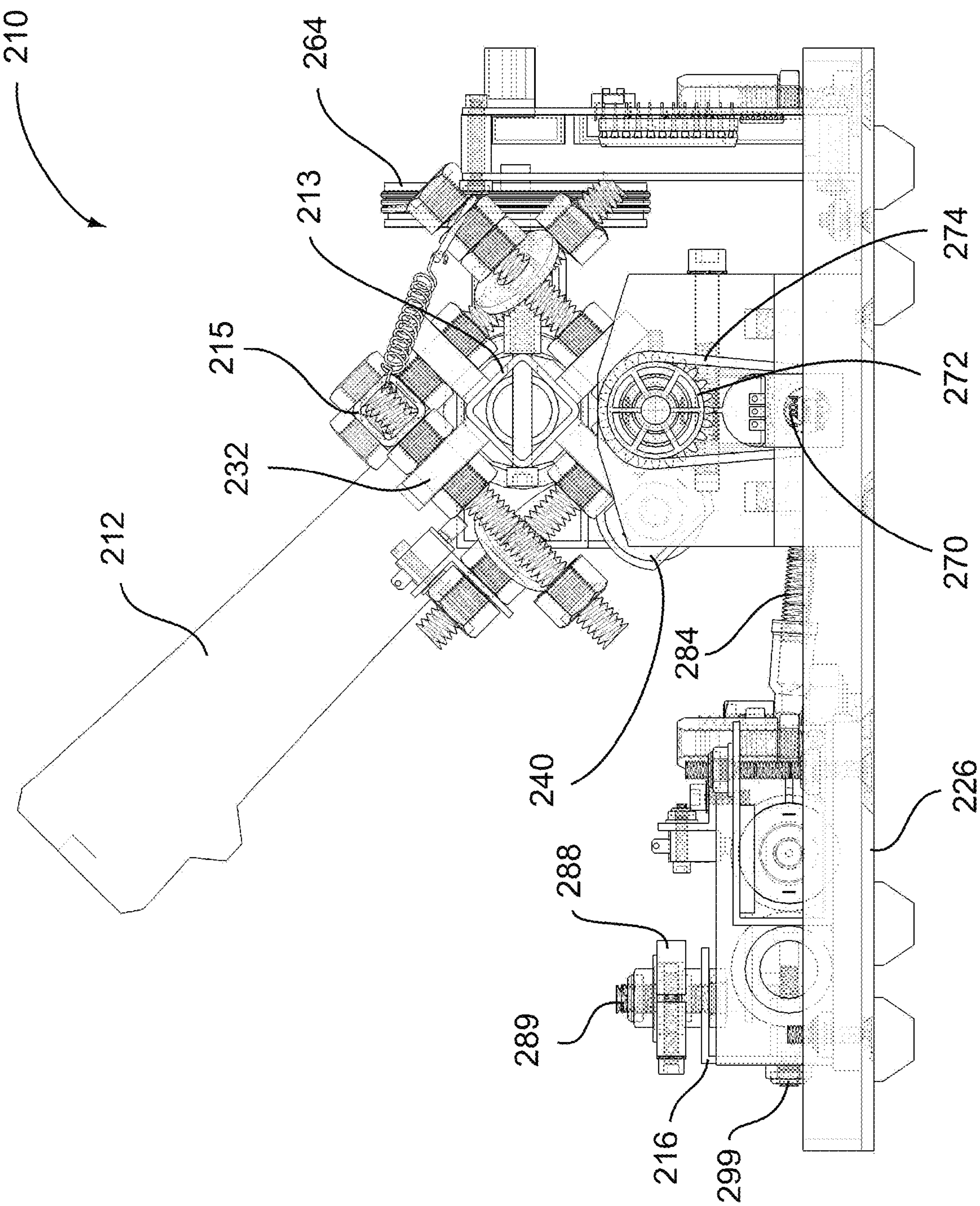


FIG. 10

FIG. 11



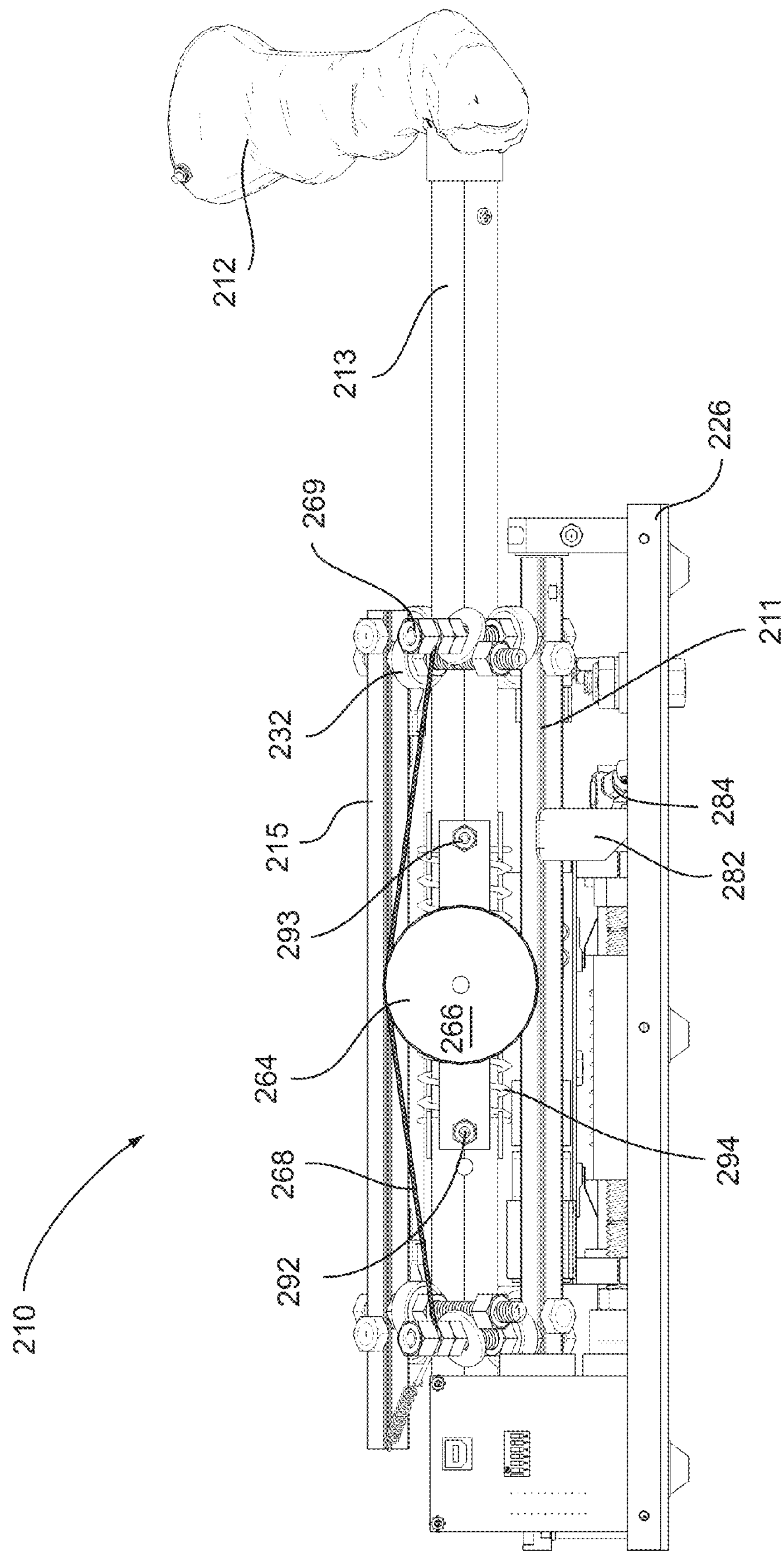


FIG. 12

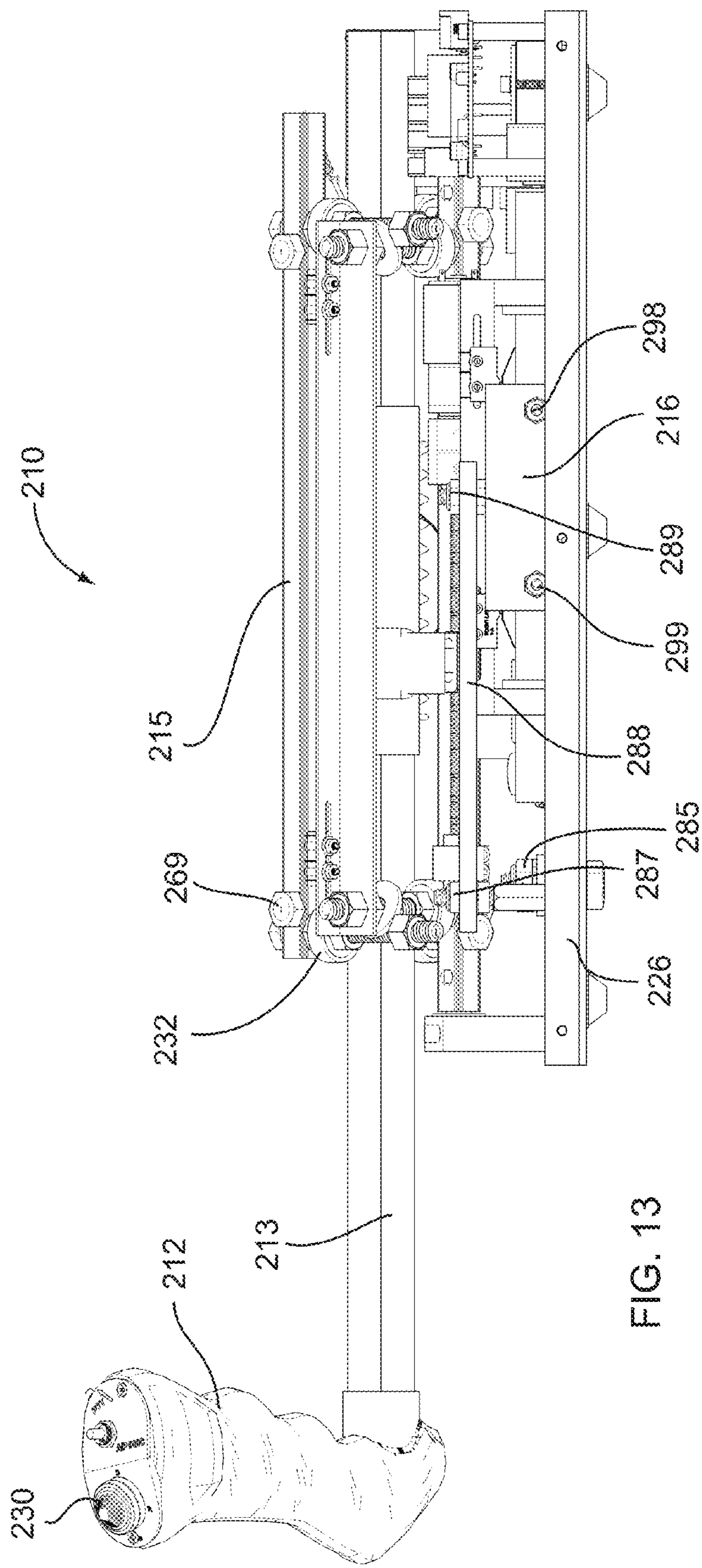


FIG. 13

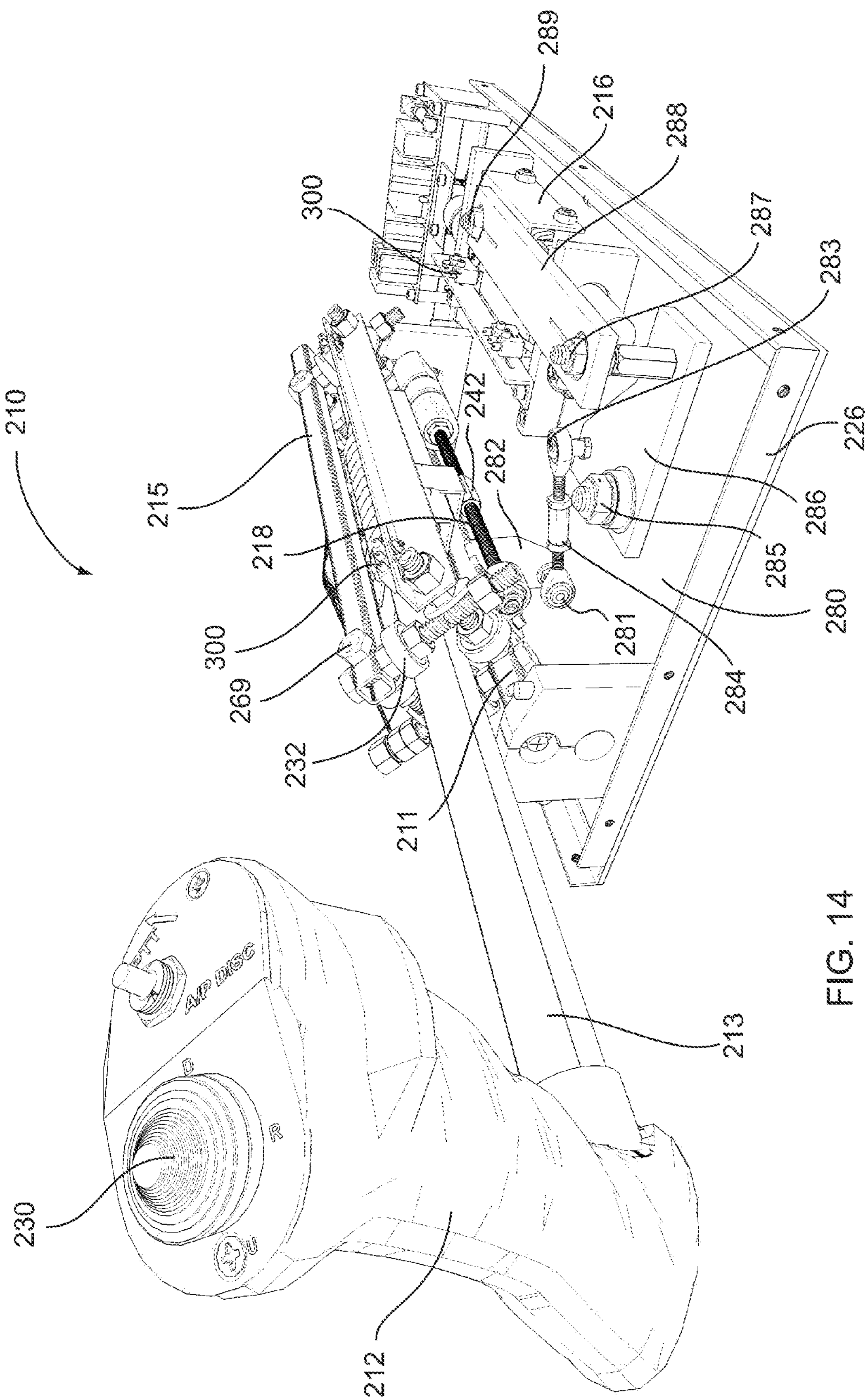

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FIG. 14

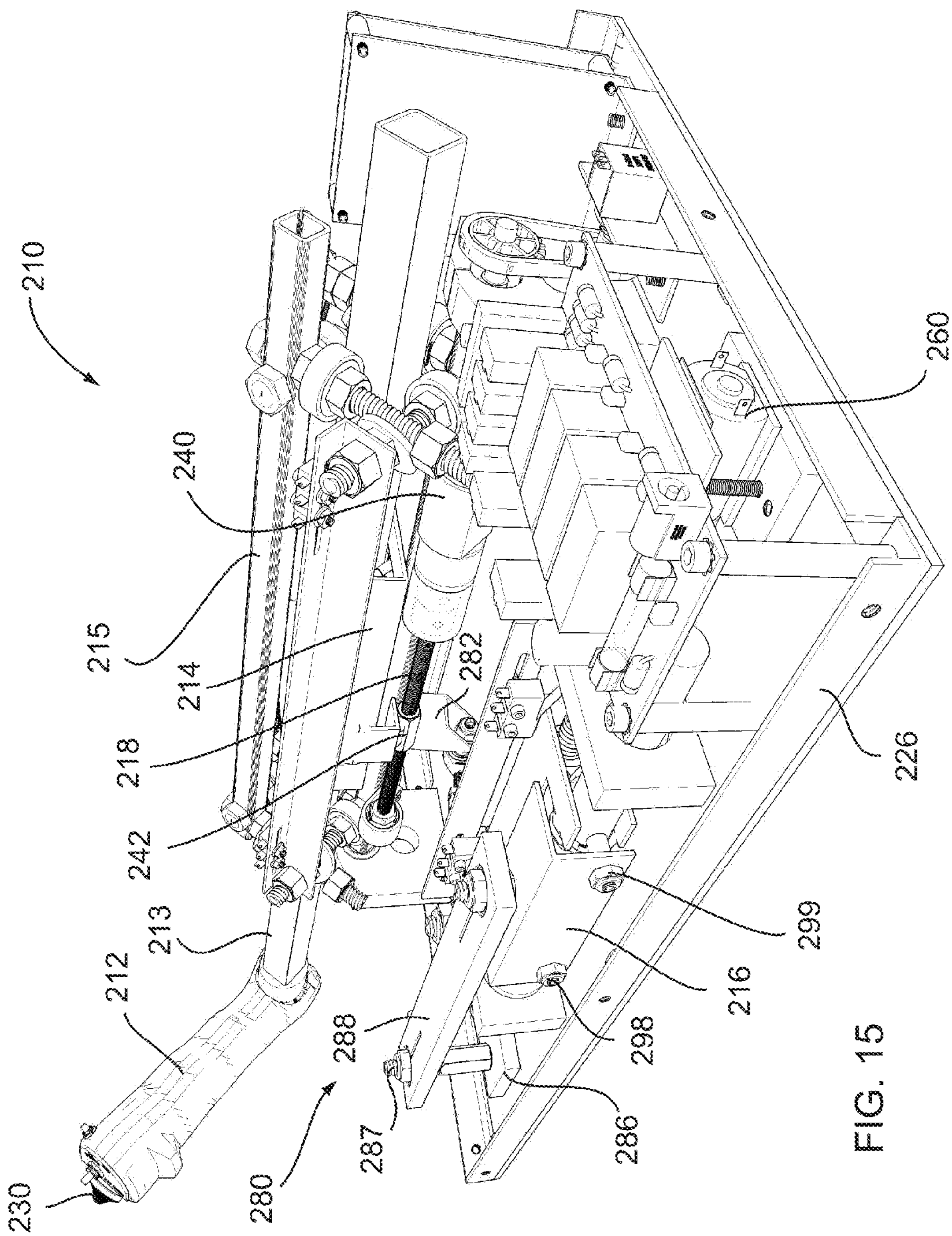
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FIG. 15

FLIGHT SIMULATOR YOKE

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of U.S. patent application entitled "FLIGHT SIMULATOR YOKE," Ser. No. 12/263,242, filed Oct. 31, 2008, which claims priority to U.S. Provisional Patent Application entitled "FLIGHT SIMULATOR YOKE," Ser. No. 61/028,674, filed Feb. 14, 2008, the disclosures of which are hereby incorporated entirely herein by reference.

BACKGROUND OF THE INVENTION

1. Technical Field

This invention relates generally to a flight simulator yoke and more particularly to a flight simulator yoke for a Cirrus SR20 aircraft.

2. State of the Art

There are several types of simulator yokes currently available that provide the ability to simulate the feel of a yoke a particular aircraft. This allows for interactive training of a pilot and allows them to learn particular aspects of flying without the need of actually flying an aircraft.

All light aircraft in the past have had either a joystick in the center, or a "broken steering wheel" type yoke. A new company named "Cirrus Design" has built an entirely new aircraft with an entirely new control system. This control is different from any other light aircraft. This control, without limitation, is visually different, moves differently, is spring loaded differently, is positioned differently in the cockpit, and its electric trim function actually moves the yoke.

Specifically, the Cirrus yoke is different in the following ways. [Describe each difference.]

The use of conventional simulator yokes are becoming more popular, particular in instances where those training to be a pilot may utilize a particular number of hours spent in a simulator as actual flight time. These conventional flight simulator yokes however have their limitations.

Among other limitations and for exemplary purposes only, conventional flight simulators are limited in their ability to accurately simulate all types of aircraft yoke. Particularly, there is no conventional simulator yoke for simulating a Cirrus SR20 aircraft. Further, conventional simulator yokes are limited in their ability to simulate an electric trim that actuates a mechanical response of an aircraft within a portable unit. Further still, conventional simulator yokes do not provide for a positive spring detent in two axes.

Accordingly, there is a need in the field of flight simulator yokes for an improved flight simulator yoke to overcome the limitations of conventional simulator yokes.

DISCLOSURE OF THE INVENTION

The present invention relates to a single handed flight simulator yoke for placement on a left side of the pilot. The simulator yoke simulates the function and operation of a Cirrus SR20 yoke. It is important to note that in order for a simulator yoke to be of value, it is necessary to mimic an actual yoke. It is in the realistic simulation of the operation and feel of a Cirrus yoke that provides pilot training, which ultimately aides in saving lives by simulating what the pilot in training will experience in a real Cirrus aircraft. Simulation has become a more critical component in the training of pilots due in part to the fact that simulation hours can be utilized as flight hours in a student pilot's training requirements. Without

accurate simulation of the aircraft being trained on, the student pilots' training is lacking, inefficient and unsafe. Accordingly, a flight simulator is provided that enables a student pilot to train on a simulation yoke that accurately and realistically mimics a Cirrus yoke.

All light aircraft in the past have had either a joystick in the center, or a "broken steering wheel" type yoke. A new company named "Cirrus Design" has built an entirely new aircraft with an entirely new control system. This control is different from any other light aircraft. This control, without limitation, is visually different, moves differently, is spring loaded differently, is positioned differently in the cockpit, and its electric trim function actually moves the yoke. This simulator yoke accurately addresses all these differences in a compact desktop unit, which can then be incorporated into any training device or simulator, for training pilots in the operation of the Cirrus aircraft.

Aspects of the Cirrus yoke that differ from conventional aircraft yokes include: (1) a different look, wherein the Cirrus yoke has a pistol grip like a joystick, but it is connected to a horizontal shaft like a yoke; (2) it moves differently, wherein the left/right axis is rotational about a center point that is tilted 45 degrees right, the forward and back axis is linear; (3) it is spring loaded differently, wherein most aircraft have a soft center detent, but the Cirrus is so heavily spring loaded that it requires several pounds of pressure to begin moving it off the center detent; (4) it is positioned differently in the cockpit, namely it is at the far left of the panel, wherein the neutral left/right rotation is tilted 45 degrees right and corresponds to a long arm rest in the door which causes the pilots hand to comfortably rest on the tilted pistol grip; and (5) it has a unique electric trim, wherein a thumb switch on the pistol grip (or the autopilot, if engaged) cause motors to actually move the detent positions of the yoke, allowing the pilot to still manually control the aircraft, but when the control is released, the aircraft will fly according to the trim setting prior to manual control, or as the autopilot directs, if it is engaged.

An aspect of particular embodiments of the invention may include a portable flight simulator yoke comprising a single handle having a handgrip and yoke shaft, wherein a first neutral position for the handle is at a 45 degree angle. Embodiments of the flight simulator yoke may further comprise a first trim axis comprising a potentiometer to measure linear movement of the single handle and a second trim axis substantially parallel to the first trim axis, wherein the second trim axis comprises a potentiometer to measure rotational movement of the single handle. Additionally, embodiments may also comprise a first and second moveable spring devices, each operatively and respectively coupled to the first and second trim axes such that movement of the single handle is measured by the potentiometers in response to movement of the spring devices, each spring device having a positive center detent, wherein the positive center detent requires a predetermined amount of force in order to move the yoke along each trim axis.

Embodiments of a portable flight simulator yoke may further comprise an electric trim having two bi-directional motors adapted to trim the yoke without manual input on the handle; and a translation mechanism to translate rotational movement of the handle to linear movement of the second moveable spring device. Additionally, embodiments may also include a circuit electrically coupled to the potentiometers, the circuit comprising connection ports to operatively connect to a computer running flight simulation software.

Another aspect of particular embodiments of the invention may include a flight simulator having a flight simulator yoke, the simulator comprising a seat, a control panel, screens for displaying flight information and simulation, throttle controls, pedals and a flight simulator yoke. The yoke includes a single handle having a handgrip and yoke shaft, wherein a neutral position for the handle is at a 45 degree angle; a first trim axis comprising a potentiometer to measure linear movement of the single handle; a second trim axis substantially parallel to the first trim axis, wherein the second trim axis comprises a potentiometer to measure rotational movement of the single handle; and a first and second moveable spring devices, each operatively and respectively coupled to the first and second trim axes such that movement of the single handle is measured by the potentiometers in response to movement of the spring devices, each spring device having a positive center detent, wherein the positive center detent requires a predetermined amount of force in order to move the yoke along each trim axis.

The foregoing and other features and advantages of the present invention will be apparent from the following more detailed description of the particular embodiments of the invention, as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a flight simulator yoke in accordance with the present invention.

FIGS. **2**A-**2**B are perspective views of a first spring device of a flight simulator yoke in accordance with the present invention.

FIG. **3** is a top view of a second spring device of a flight simulator yoke, in accordance with the present invention.

FIGS. **4**A-**4**C are end views of a translation mechanism of a flight simulator yoke in accordance with the present invention.

FIGS. **5**A-**5**C are end views of an alternate embodiment of a translation mechanism of a flight simulator yoke.

FIGS. **6**A-**6**C are perspective view of a spring device of a flight simulator yoke.

FIG. **7** is a perspective view of a flight simulator having a flight simulator yoke in accordance with the present invention.

FIG. **8**A is a top view of a dual handle flight simulator yoke.

FIG. **8**B is a section view of a dual handle flight simulator yoke taken along line B-B of FIG. **8**A.

FIG. **8**C is a section view of a dual handle flight simulator yoke taken along line C-C of FIG. **8**A.

FIG. **8**D is a top view of another embodiment of a flight simulator yoke with two handles.

FIG. **9** is a top view of a flight simulator yoke with parallel trim axes.

FIG. **10** is a front view a flight simulator yoke with parallel trim axes.

FIG. **11** is a back view of a flight simulator yoke with parallel trim axes.

FIG. **12** is a left side view of a flight simulator yoke with parallel trim axes.

FIG. **13** is a right side view of a flight simulator yoke with parallel trim axes.

FIG. **14** is a perspective view of a flight simulator yoke with parallel trim axes showing a translation mechanism.

FIG. **15** is another perspective view of a flight simulator yoke with parallel trim axes showing a translation mechanism.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

As discussed above, embodiments of the present invention relate to a single handed flight simulator yoke for placement on a left side of the pilot. The simulator yoke simulates the function and operation of a Cirrus SR20 yoke. Generally, a simulator yoke according to present invention is necessary to realistically mimic an actual Cirrus SR20 yoke in operation and feel. The realistic operation and feel of the simulator yoke provides pilot training, which ultimately aides in saving lives by simulating what the pilot in training will experience in a real Cirrus aircraft. Each component selected and utilized by embodiments of the present invention are intended to replicate the feel and provide the proper feedback to the student pilot in order to provide proper training.

Referring to the drawings, FIG. **1** depicts a perspective view of a single handle flight simulator yoke **10** according to particular embodiments of the present invention. The simulator yoke **10** may include a handgrip **12**, a yoke shaft **13**, a first trim axis **18** and a second trim axis **20**. The handgrip **12** is coupled to the yoke shaft **13** and allows the handgrip **12** and the yoke shaft **13** to move rotationally about a rotation axis **11**, wherein the rotation axis **11** is a predetermined distance from an axis of the yoke shaft **13**. The simulator yoke **10** may further include a first spring device **14** and a second spring device **16**. Further still, the simulator yoke **10** may include a trim thumb switch **30** for controlling the electric trim as will be discussed in greater detail with respect to FIGS. **2**A, **2**B and **3**.

The hand grip **12** simulates the hand grip of a Cirrus SR20 in all aspects including finger recesses as well as being positioned at approximately a forty-five degree angle. The hand grip **12** includes a thumb switch **30**. The thumb switch **30** may be operatively coupled to each trim axis **18** and **20**. As the thumb switch **30** may be moveable back and forth in at least two directions. The direction is associated with the each trim axis **18** and **20**. The movement of the thumb switch activates the movement of the electric trim axes **18** and **20**.

With additional reference to FIGS. **2**A and **2**B, the first electric trim axis **18** includes a motor **40** and a spring device coupler **42**. The motor **40** may be a bi-directional motor that allows rotation in two directions. The first trim axis **18** may be a worm driven axis wherein the spring device coupler **42** travels linearly along the first trim axis **18** in response to the rotation of the trim axis **18** in each rotational direction. The spring device coupler **42** is coupled to the first spring device **14**. Therefore, the translational movement of the spring device coupler **42** also moves the spring device linearly along the first trim axis **18** in response to the rotation of the first trim axis **18**.

The first spring device **14** has a center position with a positive detent, wherein it requires a predetermined amount of force to manually move the hand grip **12** and the yoke shaft in a direction along the first trim axis **18**. Movement of the spring device **14** along the first trim axis **18** moves the center of the first spring device **14** in response to the adjustment of the electric trim by use of the thumb switch **30**. This accurately simulates the movement of the center detent of the Cirrus SR20 yoke, wherein the center moves in response to the trim adjustments.

Referring further to the drawings and particularly to FIG. **3**, the second electric trim axis **20** includes a motor **60** and a spring device coupler (not shown). The motor **60** may be a bi-directional motor that allows rotation in two directions. The second trim axis **20** may be a worm driven axis wherein the spring device coupler travels linearly along the second trim axis **20** in response to the rotation of the trim axis **20** in each rotational direction. The spring device coupler is coupled to the second spring device **16**. Therefore, the translational movement of the spring device coupler also moves the spring device linearly along the second trim axis **20** in response to the rotation of the second trim axis **20**.

The second spring device **16** has a center position with a positive detent, wherein it requires a predetermined amount of force to manually move the hand grip **12** and the yoke shaft in a direction along the second trim axis **20**. Movement of the spring device **16** along the second trim axis **20** moves the center of the second spring device **16** in response to the adjustment of the electric trim by use of the thumb switch **30**. This accurately simulates the movement of the center of the Cirrus SR20 yoke, wherein the center moves in response to the trim adjustments.

The simulator yoke **10** may further include a second resistor **70** coupled adjacent the second spring device **16**. The second resistor **70** includes a stationary portion **71** held in a position adjacent the second spring device **16** and substantially parallel to the second trim axis **20**. The second resistor further includes a moveable portion **72** that is operative coupled to the second spring device **16**, wherein the moveable portion **72** moves in response to movement of the second spring device **16**. The second resistor **70** may be utilized to communicate the position of the second spring device **16** and the center of the second spring device **16** in order to accurately communicate that position to a computer for use in a simulated flight.

Referring further to the drawings, FIG. **4** depicts a translation mechanism **80** of a flight simulator yoke in accordance with the embodiments of the present invention. The translation mechanism **80** allows for the rotational movement of the handgrip **12** and the yoke shaft **13** about the rotation axis **11**, wherein the rotation axis **11** is a predetermined distance from an axis of the yoke shaft **13**. In order for the rotational movement of the handgrip **12** and the yoke shaft **13** to simulate the rotational movement of a Cirrus SR20 yoke, there needed to be a translation of the rotational movement of the handgrip **12** and yoke shaft **13** into a linear movement along the direction of the second trim axis **20**. Accordingly, the translation mechanism **80** provides this translational movement. The translation mechanism **80** may include a bracket having opposing cantilevered sides **82** and **84**. The sides **82** and **84** may be preloaded with a predetermined amount of force in order to maintain the proper operation of the translation mechanism **80**. The translation device may further include a plurality of bearings or rollers **86** coupled on opposing sides of a translation shaft **15**. The translation shaft **15** operatively engages the second spring device **16**, wherein the second spring device **16** provides a center detent that requires a predetermined force in order to rotate the handgrip **12** and the yoke shaft **13**.

In operation, one of the sides **82** and **84** of the translation mechanism **80** engages a portion of the bearings or rollers **86** and moves the bearings in a linear direction substantially similar to the direction of the second trim axis **20**. The translation shaft **15** move linearly in a simultaneous response to the movement of the bearings **86**. The side **82** or **84** that engages the bearings **86** is dependent upon the direction of rotation of the handgrip **12**.

Referring further to the drawings; FIG. **5** depicts an alternate embodiment of a translation mechanism **100**. The translation mechanism **100** may include a bracket **101** coupled to the member having rotation axis **11**, wherein rotation of the handgrip **12** results in rotation of the bracket **101**. The translation mechanism **100** may further include a translation bar **102** coupled between a pivot point **104** coupled to the bracket **101** and pivot point **106** coupled to the translation shaft **15**. As the bracket **101** is rotated, the translation bar **102** moves the translation shaft **15** from side to side in response to the rotation of the bracket **101**. Other features of the translation mechanism **100** and the flight simulator yoke **10** are the same as previously described.

FIG. **6** depicts various views of a spring device **14** in accordance with embodiments of the present invention. The spring device **14** may include a first bracket **90** and a second bracket **91**. The spring device **14** may also include a first pin **92** and a second pin **93**. Further still the spring device **14** may include a first spring **94** and a second spring **96**. The first and second springs **94** and **96** are coupled about shaft **13** adjacent each other and in contact with each other when the shaft **13** is in a neutral position, as shown in FIG. **6**A. The brackets **90** and **91** are maintained stationary within the flight simulator yoke **10**. The pins are coupled to the shaft **13**, and move in response to movement of the shaft **13**. The first pin **92** is coupled adjacent the first bracket **90**, wherein the first pin **92** and the first bracket **90** each engage an end of the first spring **94**, when the shaft **13** is in a neutral position. The second pin **93** is coupled adjacent the second bracket **91**, wherein the second pin **93** and the second bracket **91** each engage an end of the second spring **95**, when the shaft **13** is in a neutral position.

As the shaft **13** is moved in a first direction, as shown in FIG. **6**B, the second pin **93** engages the second spring **95** and the first bracket **90** engages the first spring **94** such that the first and second springs **94** and **95** compress until they are fully compressed. As the shaft **13** is moved back into neutral position the springs **94** and **95** are expanded again. The shaft **13** may also be moved in a second direction shown in FIG. **6**C. The first pin **92** engages the first spring **94** and the second bracket **91** engages the second spring **95** such that the first and second springs **94** and **95** compress until they are fully compressed. As the shaft **13** is moved back into neutral position the springs **94** and **95** are expanded again. It will be understood that the spring device **16** operates in substantially the same manner as the spring device **14**.

Referring again to FIG. **1**, the simulator yoke **10** may also include a power source **22**, an electrical wire harness and a plurality of wires **24**. The power source **22** provides power to the simulator yoke **10** and allows all electric and electronic components to function and operate. The wire harness **23** allows for a central location of connecting wires together and the wire **24** allow for the transmission of particular signals in order to operate the electric and electronic aspects of the simulator yoke, such as, but not limited to movement of the electric trim, the sending and receiving of information via a USB connection to a computer or simulator of information with regard to the position of the simulator yoke **10** and the associated manual movements of the yoke. The power source **22**, wire harness **23** and wires **24** essentially allow for the ability of the simulator yoke to operate as well as allow the simulator yoke **10** to communicate with a computer as part of a simulation flight.

Additionally, the simulator yoke **10** may include a base **26**. The base **26** may be used to support all of the components of the simulator yoke **10** and may further be used to rest upon a surface during use. According to other embodiments, the base **26** may be secured to a surface within a flight simulator or on a desk by a home computer. The base allows for the yoke **10** to be portable and moved from surface to surface.

Referring again to the drawings, FIG. **7** depicts a flight simulator **110** in accordance with the present invention. The flight simulator **110** may include features typical of a flight simulator, such as, but not limited to a seat **111**, instrument panel **112**, instrument screen **114**, flight screens **116** and **117**, throttle controls **118** and pedals **120**. The flight simulator may also include a flight simulator yoke **10** in accordance with the present invention. It will be understood that the flight simulator yoke **10** enables the flight simulator to mimic and simulate a Cirrus aircraft.

Referring further to FIGS. **8**A-**8**D, other embodiments of the present invention may include a flight simulator that requires a dual handle flight simulator yoke **130** with a first and second handle **132** and **134** in order to further simulate a Cirrus aircraft. Each handle **132** and **134** has a handgrip **136** and **138**. The first handle **132** is operable from a left side of a first user and the second handle **134** operable from the right side of a second user, wherein a neutral position for each the first and second handle **132** and **134** is at a 45 degree angle. The dual handle yoke **130** may include one yoke **10** that may be similar to the yoke previously discussed in the application, where like numbers refer to like components. Referring additionally to FIGS. **1-4**, the yoke **10** may include a first trim axis **18** operatively coupled to a yoke shaft **13** in a linear relationship, the first trim axis **18** may be transverse to a second trim axis **20** operatively coupled to the yoke shaft **13** in a translated rotational relationship. Each trim axis **18** and **20** having a liner potentiometer to measure movement along the trim axis.

The yoke **10** may include first and second moveable spring devices **14** and **16** operatively coupled to the trim axes **18** and **20** respectively, such that movement is measured by potentiometers **50** and **70** in response to the respective movement of the first and second spring devices **14** and **16**, each spring device having a positive center detent, wherein the positive center detent requires a predetermined amount of force in order to move the yoke shaft **13** along each trim axis **18** and **20**.

The dual handle yoke **130** may include rotational linking members **140** and **142** operatively coupled between a translation shaft **15** of the yoke **10** and rotatable sleeves **141**, wherein the rotation of one of the first and second handle **132** and **134** results in the rotation of one of the sleeves **141**, thereby moving one of the rotational linking members **140** and **142** linearly. Referring to FIG. **8**C, the sleeve **141** may be held in a position by support member **143** allowing only rotational movement of the sleeve **141**. The rotational linking members **140** and **142** may be coupled to the sleeve **141** by ball joint **145**, thereby allowing the rotational movement of the sleeve **141** to translate into linear movement of the rotational linking members **140** and **142**. The linear movement of one of the rotational linking members **140** and **142** results in linear movement of the translation shaft **15**. The linear movement of translation shaft will result in linear movement of one of the rotational linking members **140** and **142** of the handle **132** and **134** that was not rotated. The other handle **132** and **134** will then rotate by the same angular distance and linear movement of the translation shaft.

The dual handle yoke **130** may include linear linking members operatively coupled to the yoke shaft **13** of the yoke **10**, wherein the linear movement of the one of the first and second handle **132** and **134** results in the linear movement of the other handle and the yoke shaft **13** a same distance in the same direction. The yoke shaft **13** may be coupled to the linear linking members in an offset configuration to accommodate rotation of the yoke shaft **13** about rotational axis **11**. In one embodiment, as shown in FIG. **8**A, the linear linking members may include cams **150** and **152** respectively coupled between the first and second handle shafts **133** and **135** and a shaft **154**. Another cam **156** may be coupled between the shaft **154** and the yoke shaft **13**. Referring to FIG. **8**B, a section view of a dual handle flight simulator yoke **130** depicts a linear linking member **150**. The other linear linking members **152** and **156** are similar. The shaft **154** may be held in a position by support members **158**, allowing only rotation of the shaft **154**. The linear linking member **150** may be coupled to the shaft **154**, such that the shaft rotates in response to rotation of the linear linking member **150**. The first handle shaft **133** may be coupled to the linear linking member **150** by a ball joint **151**. The ball joint **151** allows the linear linking member **150** to rotate in response to linear movement of the first handle shaft **150**. The other linear linking members **152** and **156** rotate in response to rotation of the shaft **154**, thereby allowing the yoke **13** and the second handle shaft **135** to move substantially the same linear distance in the same direction as the movement of the first handle shaft **133**.

In another embodiment as shown in FIG. **8**D, the linear linking members may include a first linking mechanism **160** and a second linking mechanism **180**. The first linking mechanism **160** may include a first linking member **162** pivotally coupled on one end to an end of the shaft of the first handle **132**. The first linking member **162** may be coupled to a second linking member **170** by a pin **166** coupled to a slot **172** of the second linking member **170**. The first linking member **162** has a pivot point **164**, wherein the first linking member **162** is rotatable about the pivot point **164**. The second linking member **170** has a pivot point **174**, wherein the second linking member **170** is rotatable about the pivot point **174**. The pin **166** and slot **172** configuration allow for the linking members to rotate in opposite directions without binding. The second linking member **170** may include a second slot **176** coupled to a pin **200**. The pin **200** is coupled to the yoke shaft **13**. This allows the rotation of the second linking member **170** to translate into linear movement of the yoke shaft **13**.

The second linking mechanism **180** may include a first linking member **182** pivotally coupled on one end to an end of the shaft of the second handle **134**. The first linking member **182** may be coupled to a second linking member **190** by a pin **186** coupled to a slot **192** of the second linking member **180**. The first linking member **182** has a pivot point **184**, wherein the first linking member **182** is rotatable about the pivot point **184**. The second linking member **190** has a pivot point **194**, wherein the second linking member **190** is rotatable about the pivot point **194**. The pin **186** and slot **192** configuration allow for the linking members to rotate in opposite directions without binding. The second linking member **190** may include a second slot **196** coupled to a pin **200**. The pin **200** is coupled to the yoke shaft **13**. This allows the rotation of the second linking member **190** to translate into linear movement of the yoke shaft **13**.

This configuration of first and second linking mechanisms **160** and **180** allows the linear movements of one handle to translate into linear movements of the yoke shaft and the other handle.

The rotational linking members **140** and **142** are operatively coupled to one of the second spring device **16**, wherein movement of one of the first and second handle **132** and **134** rotationally results in movement of the first spring device **16**.

The linear linking members are operatively coupled to the first spring device **14**, wherein movement of one of the first and second handle **132** and **134** linearly results in movement of the first spring device **14**.

The yoke **10** of the dual handle yoke **130** may further include an electric trim having two bi-directional motors adapted to trim the yoke without manual input on one of the first and second handles. Each of the first and second handles **132** and **134** may comprise a thumb switch operatively coupled to the handgrip wherein the two bi-directional motors operate in response to movement of the thumb switch. The two bi-directional motors are mechanically coupled to threaded rods that are parallel to the two trim axes, wherein the threaded rods move in response to operation of the two motors.

It will be understood that this configuration of a dual handle yoke **130** results in one handle moving simultaneously when the other handle is moved. The movements will be substantially identical in direction and distance. This movement includes movement due to electronic trim adjustments.

Referring to the drawings, FIGS. **9-15** depict a single handle flight simulator yoke **210** according to particular embodiments of the present invention. The simulator yoke **210** may include a handgrip **212**, a yoke shaft **213**, a first trim axis **218** and a second trim axis **220**. The handgrip **212** is coupled to the yoke shaft **213** and allows the handgrip **212** and the yoke shaft **213** to move rotationally about a rotation shaft **211**, wherein the axis of the rotation shaft **211** is a predetermined distance from an axis of the yoke shaft **213**. The simulator yoke **210** may further include a first spring device **214** and a second spring device **216**. Further still, the simulator yoke **210** may include a trim thumb switch **230**.

The yoke **210** comprises two axes of movement; a linear axis and a rotational axis. The yoke **210** is moveable linearly in a direction that is parallel with the yoke shaft **213**, and the yoke **210** is rotational about an axis that is offset below the yoke shaft **213**. The yoke **210** has an initial neutral position that may be adjusted by use of the electric trim and the first and second trim axes **218** and **220**. The initial neutral position includes the yoke handgrip **212** in the neutral position with respect to the rotational axis of 45 degrees. It will be understood that from a front view of the yoke **210** the handgrip **212** is angled at approximately 45 degrees up and to the right for a yoke **210** configured for a left-handed unit and angled at approximately 45 degrees up and to the left for a yoke **210** configured for a right-handed unit.

The hand grip **212** simulates the hand grip of a Cirrus SR20 in all aspects including finger recesses as well as being positioned at approximately a forty-five degree angle. The hand grip **212** includes a thumb switch **230**. The thumb switch **230** may be operatively coupled to each trim axis **218** and **220**. The thumb switch **230** may be moveable back and forth in at least two directions. The direction is associated with the each trim axis **218** and **220**. The movement of the thumb switch activates the movement of the electric trim axes **218** and **220**.

With regard to the purpose and function of electric trim, it is important to understand how the trim functions in an airplane such as the Cirrus SR20. There are two trim systems; a pitch trim system and a roll trim system. Roll and pitch trim are provided by adjusting the neutral position of a compression spring cartridge in each control system by means of an electric motor. The electric roll trim is also used by the autopilot to position the ailerons. It is possible to easily override full trim or autopilot inputs by using normal control inputs. Ground adjustable trim tabs are installed on the rudder, elevator and right aileron to provide small adjustments in neutral trim. These tabs are factory set and do not normally require adjustment.

With regard to the pitch trim control system, an electric motor changes the neutral position of the spring cartridge attached to the elevator control horn. A conical trim button located on top of each control yoke controls the motor. Moving the switch forward will initiate nose-down trim and moving the switch aft will initiate nose-up trim. Pressing down on the switch will disconnect the autopilot if the autopilot was engaged. Neutral (takeoff) trim is indicated by the alignment of a reference mark on the yoke tube with a tab attached to the instrument panel bolster. The elevator trim also provides a secondary means of aircraft pitch control in the event of a failure in the primary pitch control system not involving a jammed elevator. Elevator (pitch) trim operates on 28 VDC supplied through the 2-amp PITCH circuit breaker on Main Bus 1.

With regard to the roll trim control system, an electric motor changes the neutral position of a spring cartridge attached to the left actuation pulley in the wing. A conical trim button located on top of each control yoke controls the motor. Moving the switch left will initiate left-wing-down trim and moving the switch right will initiate right-wing-down trim. Pressing down on the switch will disconnect the autopilot if the autopilot was engaged. Neutral trim is indicated by the alignment of the line etched on the control yoke with the centering indication marked on the instrument panel. The aileron trim also provides a secondary means of aircraft roll control in the event of a failure in the primary roll control system not involving jammed ailerons. Aileron trim operates on 28 VDC supplied through the 2-amp ROLL TRIM circuit breaker on Main Bus 1.

In aircraft such as the Cirrus SR20, the adjustments made by use of the electric trim not only change the flight attitude of the aircraft, but it further adjusts the attitube of the yoke, or in other words adjusts the neutral position of the yoke, such that the plane will go back to the adjusted flight attitude established by the trim adjustments. Similarly, the adjustment of the electric trim of the present invention adjusts the attitude of the yoke **210** by use of trim axes **218** and **220**. The neutral position of the yoke **210** is adjusted in response to adjustment of the yoke **210** along the electric trim axes **218** and **220**.

The first electric trim axis **218** includes a motor **240** and a spring device coupler **242**. The motor **240** may be a bi-directional motor that allows rotation in two directions. The first trim axis **218** may be a threaded rod, such as but not limited to a drive screw, wherein the spring device coupler **242** travels linearly along the first trim axis **218** in response to the rotation of the trim axis **218** in each rotational direction. The spring device coupler **242** is coupled to the first spring device **214**. Therefore, the linear movement of the spring device coupler **242** also moves the spring device linearly along the first trim axis **218** in response to the rotation of the first trim axis **218**.

Additionally, the yoke **210** may also comprise sensors **310**, wherein two sensors **310** are coupled adjacent the first spring device **214** a predetermined distance apart. Further, two sensors **310** are coupled adjacent the second spring device **216** a predetermined distance apart. The sensors **310** are coupled such that the first and second spring devices **214** and **216** may engage the sensors **310** adjacent each spring device. In response to the first or second spring device **214** or **216** respectively engaging one of the corresponding sensors **310**, the first motor **240** or the second motor **260** stop movement in the current direction of rotation and is only allowed rotation in the opposite direction.

The simulator yoke **210** may further include a first potentiometer and a second potentiometer, wherein the first potentiometer **264** measures linear movement of the first spring device **214**. The first potentiometer **264**, according to some embodiments, may include a rotary potentiometer **264**, wherein the potentiometer **264** comprises a pulley **266** with string **268** fixedly coupled to a support bolt **269** of the yoke **210** on one end and to the end of the yoke shaft **213** opposing the handle **212** on the other end. As the spring device **214** moves linearly along the yoke shaft **213**, the string **268** functions to rotate a rotational disc of the pulley **266** that further rotates the potentiometer **264**, thereby adjusting the resistance of the potentiometer **264** and producing a varied signal with regard to the previous signal. The linear movement of the spring device **214** may be manual movement or movement in response to adjusting the trim by use of the thumb switch **30**. For example, the user may apply force to the handle **212** which moves the yoke shaft **213** linearly, and thereby rotates the first potentiometer **264** by moving the opposing end of the yoke shaft **213**, resulting in rotation of the pulley **266**. This change in resistance is directed to a computer through an electrical connection, wherein the yoke **210** provides a signal to the computer for computer simulator software to function with assistance of a processor to process the signal generated by the yoke **210** to accurately simulate the flying of an aircraft like a Cirrus SR20.

The first spring device **214** has a center position with a positive detent, wherein it requires a predetermined amount of force to manually move the hand grip **212** and the yoke shaft in a direction along the first trim axis **218**. Movement of the spring device **214** along the first trim axis **218** moves the center of the first spring device **214**. For example, the center detent of the first spring device **214** may be moved in response to the adjustment of the electric trim by use of the thumb switch **230**. This accurately simulates the movement of the center detent of the Cirrus SR20 yoke, wherein the center moves along the length of the yoke shaft **213** in response to the trim adjustments. Once the trim is set by use of the thumb switch **230**, a new neutral position is provided by having the resting position of the yoke shaft in the orientation established by the change in location of the first spring device **214**.

The second electric trim axis **220** includes a motor **260** and a spring device coupler. The motor **260** may be a bi-directional motor that allows rotation in two directions. The second trim axis **220** may be a threaded rod, such as but not limited to a lead screw, wherein the spring device coupler travels linearly along the second trim axis **220** in response to the rotation of the trim axis **220** in each rotational direction. The spring device coupler is coupled to the second spring device **216**. Therefore, the linear movement of the spring device coupler also moves the spring device linearly along the second trim axis **220** in response to the rotation of the second trim axis **220**.

The yoke **210** may further comprise a second rotary potentiometer **270** operatively coupled to the rotational shaft **211**. For example, second potentiometer **270** may be coupled to a gear **272** coupled to an end of the rotational shaft **211**, wherein the gear is connected to the potentiometer **270** by use of a belt **274**, wherein rotation of the shaft **211** results in rotation of the rotary potentiometer **270**. The second potentiometer **270** may be utilized to communicate the angular position of the hand grip **212** and the yoke shaft **213**. This angular position may also be adjusted by movement of the second spring device **216** and the center of the second spring device **216** in order to accurately communicate said position to a computer for use in a simulated flight.

The second spring device **216** has a center position with a positive detent, wherein it requires a predetermined amount of force to manually move the hand grip **212** and the yoke shaft in a direction along the second trim axis **220**. Movement of the spring device **216** along the second trim axis **220** moves the center of the second spring device **216** in response to the adjustment of the electric trim by use of the thumb switch **230** in moving the thumb switch **230** in a direction transverse to the yoke shaft **213**. The movement of the second spring device moves the linear member **288**. Movement of linear member **288** rotates rotational member **286**. Rotation of the rotational member **286** moves the adjustable linkage **284**, which thereby moves yoke shaft member **282** that results in rotation of the yoke shaft **213** and ultimately the rotation handle **212**. This accurately simulates the movement of the center of the Cirrus SR20 yoke, wherein the center moves along the second trim axis **220** in response to the trim adjustments. Once the trim is set by use of the thumb switch **230**, a new neutral position is provided by having the resting position of the yoke shaft in the orientation established by the change in location of the first spring device **216**.

It will be understood that movement of the spring devices **214** and **216** along their respective trim axes results in defining a new neutral position of the handle **212** and yoke shaft **213**, wherein neutral is determined as no external force acting on the handle **212**. The use of trim in an aircraft changes the attitude of the aircraft, such as placing the airplane in a descent or an ascent. Accordingly, the electric trim of the simulator yoke **210** functions to provide a simulation of the electric trim of the Cirrus SR20 yoke, and further provides for input to the computer for use with a simulation software.

Embodiments of the flight simulator yoke **210** comprise a translation mechanism **280** in accordance with the embodiments of the present invention. The translation mechanism **280** allows for the rotational movement of the handgrip **212** and the yoke shaft **213** about the rotation shaft **211**, wherein the rotation shaft **211** is a predetermined distance from an axis of the yoke shaft **213**. In order for the rotational movement of the handgrip **212** and the yoke shaft **213** to simulate the rotational movement of a Cirrus SR20 yoke, there needs to be a translation of the rotational movement of the handgrip **212** and yoke shaft **213** into a linear movement along the direction of the second trim axis **220**. Accordingly, the translation mechanism **280** provides this translational movement. The translation mechanism **280** may include a yoke shaft member **282**, an adjustable linkage **284**, a rotational member **286** and a linear member **288**. The adjustable linkage **284** is operatively coupled between the yoke shaft member **282** and the rotational member **286**, wherein the adjustable linkage **284** established an angle α with respect to the base **226** of the yoke **210** when the hand grip **212** is at substantially 45 degrees. For the exemplary purposes of this disclosure, the adjustable linkage **284** may include pivot points on each end at pivot point **289** and pivot point **292** on the rotational member **286**, thereby allowing rotation of the yoke shaft member **282** to rotate in one plane and the rotational member **286** to rotate in another plane transverse to the plane of rotation of the yoke shaft member **282**. The linear member **288** is operatively coupled between the second moveable spring device **216** and the rotational member **286**. The linear member **286** is coupled to the rotational member **286** at pivot point **294**. This pivot point **294** allows for translation of the rotational movement of the rotational member **286** to the linear movement of the linear member **286**.

In operation, the rotational member **286** rotates about an axis, such as the axis of pivot point **290** in response to the rotation of the yoke shaft member **282** about the yoke rotational shaft **211**. The linear member **288** moves linearly in response to rotation of the rotational member **286** about pivot point **290**. The second moveable spring device **216** moves linearly along the second trim axis **220** in response to linear movement of the linear member **288**.

The yoke shaft **213** further comprises a yoke shaft support system. The support system comprises a support shaft wherein support bolts that couple rollers or bearings **232** to the support shaft, wherein the bearings **232** operatively engage the yoke shaft **213**. The bearings **232** allow the yoke shaft **213** to move linearly with little friction and provide a feel similar to the actual aircraft.

The spring device **214** may include a first bracket **290** and a second bracket **291**. The spring device **214** may also include a first pin **292** and a second pin **293**. Further still the spring device **214** may include a spring **294**. The spring **294** is coupled about yoke shaft **213**. The brackets **290** and **291** are maintained stationary within the flight simulator yoke **210**. The pins **292** and **293** are coupled to the yoke shaft **213**, and move in response to movement of the yoke shaft **213**. The first pin **292** is coupled adjacent the first bracket **290**, wherein the first pin **292** and the first bracket **290** each engage an end of the spring **294**, when the yoke shaft **213** is in a neutral position. The second pin **293** is coupled adjacent the second bracket **291**, wherein the second pin **293** and the second bracket **291** each engage an end of the second spring **295**, when the yoke shaft **213** is in a neutral position.

As the yoke shaft **213** is moved in a first direction, the second pin **293** engages the other end of spring **294** and the first bracket **90** engages an end of the spring **294** such that the spring **294** compresses until it is fully compressed. As the yoke shaft **213** is moved back into neutral position the spring **294**.

The yoke shaft **213** may also be moved in a second direction. The first pin **292** engages the first spring **294** and the second bracket **291** engages the second spring **295** such that the spring **294** compresses until they are fully compressed. As the yoke shaft **213** is moved back into neutral position the spring **94** are expanded again. It will be understood that the spring device **216** operates in substantially the same manner as the spring device **214**.

It will be understood that all the proper circuitry provides the proper connection and interface with a computer and the software.

Accordingly, the components defining any flight simulator yoke implementation may be formed of any of many different types of materials or combinations thereof that can readily be formed into shaped objects provided that the components selected are consistent with the intended operation of a flight simulator yoke implementation. For example, the components may be formed of: rubbers (synthetic and/or natural) and/or other like materials; glasses (such as fiberglass) carbon-fiber, aramid-fiber, any combination thereof, and/or other like materials; polymers such as thermoplastics (such as ABS, Fluoropolymers, Polyacetal, Polyamide; Polycarbonate, Polyethylene, Polysulfone, and/or the like), thermosets (such as Epoxy, Phenolic Resin, Polyimide, Polyurethane, Silicone, and/or the like), any combination thereof, and/or other like materials; composites and/or other like materials; metals, such as zinc, magnesium, titanium, copper, iron, steel, carbon steel, alloy steel, tool steel, stainless steel, aluminum, any combination thereof, and/or other like materials; alloys, such as aluminum alloy, titanium alloy, magnesium alloy, copper alloy, any combination thereof, and/or other like materials; any other suitable material; and/or any combination thereof.

Furthermore, the components defining any flight simulator yoke implementation may be purchased pre-manufactured or manufactured separately and then assembled together. However, any or all of the components may be manufactured simultaneously and integrally joined with one another. Manufacture of these components separately or simultaneously may involve extrusion, pultrusion, vacuum forming, injection molding, blow molding, resin transfer molding, casting, forging, cold rolling, milling, drilling, reaming, turning, grinding, stamping, cutting, bending, welding, soldering, hardening, riveting, punching, plating, and/or the like. If any of the components are manufactured separately, they may then be coupled with one another in any manner, such as with adhesive, a weld, a fastener (e.g. a bolt, a nut, a screw, a nail, a rivet, a pin, and/or the like), wiring, any combination thereof, and/or the like for example, depending on, among other considerations, the particular material forming the components. Other possible steps might include sand blasting, polishing, powder coating, zinc plating, anodizing, hard anodizing, and/or painting the components for example.

The embodiments and examples set forth herein were presented in order to best explain the present invention and its practical application and to thereby enable those of ordinary skill in the art to make and use the invention in a realistic simulation of the operation and feel of a Cirrus SR20 yoke in order to provide pilot training. However, those of ordinary skill in the art will recognize that the foregoing description and examples have been presented for the purposes of illustration and example only. The description as set forth is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of the teachings above without departing from the spirit and scope of the forthcoming claims.

The invention claimed is:

1. A portable flight simulator yoke comprising:

a single handle having a handgrip and yoke shaft, wherein a neutral position for the handle is at a 45 degree angle;

a first trim axis comprising a potentiometer to measure linear movement of the single handle;

a second trim axis substantially parallel to the first trim axis, wherein the second trim axis comprises a potentiometer to measure rotational movement of the single handle;

a first and second moveable spring devices, each operatively and respectively coupled to the first and second trim axes such that movement of the single handle is measured by the potentiometers in response to movement of the spring devices, each spring device having a positive center detent, wherein the positive center detent requires a predetermined amount of force in order to move the yoke along each trim axis;

an electric trim having two bi-directional motors adapted to trim the yoke without manual input on the handle;

a thumb switch operatively coupled to the handgrip wherein the two bi-directional motors operate in response to movement of the thumb switch; and

wherein the two bi-directional motors are mechanically coupled to threaded rods that are parallel to the two trim axes, wherein the threaded rods move in response to operation of the two motors.

2. The flight simulator yoke of claim **1**, wherein each spring device moves along a threaded rod corresponding to a trim axis in response to operation of the corresponding bi-directional motor, each direction of movement of the spring device corresponding to a direction of rotation of the corresponding bi-directional motor.

3. The flight simulator yoke of claim **2**, wherein the positive center detent of each spring device moves along the corresponding trim axis in response to movement of each spring device.

4. The flight simulator yoke of claim **1**, further comprising a translation mechanism to translate rotational movement of the handle to linear movement of the second moveable spring device.

5. The flight simulator yoke of claim **4**, wherein the translation mechanism comprises a yoke shaft member, an adjustable linkage, a rotational member and a linear member.

6. The flight simulator yoke of claim **5**, wherein the adjustable linkage is operatively coupled between the yoke shaft member and the rotational member.

7. The flight simulator yoke of claim **6**, wherein the linear member is operatively coupled between the second moveable spring device and the rotational member.

8. The flight simulator yoke of claim **7**, wherein the rotational member rotates about an axis in response to the rotation of the yoke shaft member about a yoke rotational shaft; the linear member moves linearly in response to rotation of the rotational member; and the second moveable spring device moves linearly along the second trim axis in response to linear movement of the linear member.

9. A flight simulator having a flight simulator yoke, the simulator comprising:

a seat;

a control panel;

screens for displaying flight information and simulation;

throttle controls;

pedals; and

a flight simulator yoke comprising:

a single handle having a handgrip and yoke shaft, wherein a neutral position for the handle is at a 45 degree angle;

a first trim axis comprising a potentiometer to measure linear movement of the single handle;

a second trim axis substantially parallel to the first trim axis, wherein the second trim axis comprises a potentiometer to measure rotational movement of the single handle;

a first and second moveable spring devices, each operatively and respectively coupled to the first and second trim axes such that movement of the single handle is measured by the potentiometers in response to movement of the spring devices, each spring device having a positive center detent, wherein the positive center detent requires a predetermined amount of force in order to move the yoke along each trim axis;

a translation mechanism comprising a yoke shaft member, an adjustable linkage, a rotational member and a linear member, the adjustable linkage operatively coupled between the yoke shaft member and the rotational member, wherein the translation mechanism translates rotational movement of the handle to linear movement of the second moveable spring device;

the rotational member rotates about an axis in response to the rotation of the yoke shaft member about a yoke shaft axis; and

the linear member operatively coupled between the second moveable spring device and the rotational member, the linear member moves linearly in response to rotation of the rotational member, and the second moveable spring device moves linearly along the second trim axis in response to linear movement of the linear member.

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